1 March 2002

The long arm of the SCADA

By Stuart Boyer

SCADA is the technology that enables a user to collect data from one or more distant facilities and/or send control instructions to those facilities. SCADA makes it unnecessary for an operator to permanently stay at or visit remote locations in the normal operation of that remote facility.

SCADA is an acronym formed from the first letters of *supervisory control and data acquisition*. Except for the fact that it doesn't refer to the factor of distance, which is common to most SCADA systems, the acronym is a good one. It rhymes with RAID-ah.

A SCADA system allows an operator in a location central to a widely distributed process, such as an oil or gas field, a pipeline system, or a hydroelectric generating complex, to make set-point changes on distant process controllers, open or close valves or switches, monitor alarms, and gather measurement information.

When the dimensions of the process become very large— hundreds or even thousands of kilometers from one end to the other—the benefits in terms of reduced cost of routine visits are appreciable. The value of these benefits will grow if the facilities are very remote and require extreme effort, such as a helicopter, to visit.

Gather meter information

SCADA technology best applies to processes that spread over large areas, are relatively simple to control and monitor, and require frequent, regular, or immediate intervention. The following examples of such processes should aid in visualizing the range of types:

- Groups of small hydroelectric generating stations that are turned on and off in response to customer demand are usually located in remote locations, can be controlled by opening and closing valves to the turbine, must be monitored continuously, and need to respond relatively quickly to demands on the electric power grid.
- Oil production facilities including wells, gathering systems, fluid measurement equipment, and pumps are usually spread over large areas, require relatively simple controls such as turning motors on and off, need to gather meter information regularly, and must respond quickly to conditions in the rest of the field.
- Pipelines for gas, oil, chemicals, or water have elements located at varying distances from a central control point, can be controlled by opening and closing valves or starting and stopping pumps, and must be capable of fast response to market conditions and leaks of dangerous or environmentally sensitive materials.
- Electric transmission systems may cover thousands of square kilometers, use opening and closing switches for control, and must respond almost immediately to load changes on the lines.

These examples are just that—examples. SCADA has successfully installed on each of these types of processes, as well as many others.

The types of control noted in these examples may give the mistaken impression that more complex control is not possible, when in fact the complexity of possible remote control has grown with the maturing of the technology.

Typical signals gathered from remote locations include alarms, status indication, analog values, and totaled meter values. However, with this seemingly limited menu of available signal types, one can collect a vast range of information.

Similarly, signals sent from the central location to the remote site are usually limited to discrete binary bit changes or analog values addressed to a device at the process. An example of a binary bit change would be an instruction ordering a motor to stop.

An analog value example would be an instruction to change a valve controller set point to 70%. Given simple signal types such as these and some imagination, one can effect many control changes.

Three blind mice: How they run

At the center of the SCADA system is the operator, who accesses the system by means of an operator interface device or an operator I/O.

The operator output, which really means system output to the operator, is usually a cathode ray tube, sometimes called a video display unit. For very simple systems, a set of annunciator windows that mimics the condition of the remote process may be sufficient. Often, an audible signal will be included.

The operator input is usually a computer keyboard, although pointing devices such as trackballs and mice are gaining in popularity. For very basic systems, a set of simple electrical switches may suffice.

The operator interfaces with the master terminal unit (MTU), which is the system controller. It is almost always a computer. It monitors and controls the field even when the operator is not present. It does this by means of a built-in scheduler that repeats instructions at set intervals. Using programmed instructions, for example, it might request an update from each remote terminal unit (RTU) every 6 minutes.

MTUs must communicate with RTUs located away from the central location. There are two common media of communication: land line, in the form of optical fiber cable or electrical cable either owned by the company or leased from a telephone utility, and radio.

In either case, a modem, which **MO**dulates and **DEM**odulates a signal on the carrier, is required. Some large systems may use a combination of radio and telephone lines for communication. Because the amount of information moved over a SCADA system tends to be rather small, the data rate at which the modem works is low.

Often 300 bits (of information) per second (bps) is sufficient. Few SCADA systems, except for those on electric utilities, need to operate at data rates above 2,400 bps. This allows voice-grade telephone line usage and does not overload most radio systems.

Normally, the MTU will have auxiliary devices such as printers and backup memory attached. These devices are a part of the MTU.

In many applications, the MTU is required to send accounting information to other computers or management information to other systems. These connections may be either direct and dedicated or in the form of LAN drops.

In a few cases, the MTU must also receive information from other computers. This is particularly true of the newer systems, where applications operating on other computers and connecting to the SCADA computer provide a form of supervisory control over SCADA.

The RTUs communicate with the MTU by a modulated signal on cable or radio. A system can contain as few as one or as many as several hundred RTUs. Each RTU must be able to understand that a message has been directed to it, decode the message, act on the message, respond if necessary, and shut down to await a new message.

Acting on the message may be a very complex procedure. It may require checking the present position of field equipment, comparing the existing position with the required position, sending an electrical signal to a field device ordering it to change states, checking a set of switches to ensure that the order was obeyed, and sending a message back to the MTU to confirm that the new condition has been reached. Because of this complexity, most RTUs leverage computer technology.

Usually electrical conductors such as wire connect the RTU and the field devices. And usually, the RTU supplies the electrical power for both actuators and sensors. Depending on the process, reliability requirements may necessitate an uninterruptible power supply to ensure that utility power failures do not result in process or safety upsets.

In the same way that the MTU scans each RTU, the RTU scans each of the sensors and actuators that wire into it. This scanning happens at a much higher scan rate than the MTU scanning.

One of the things that distinguish SCADA from most telemetry systems is that SCADA is a two-way system. With SCADA, it is possible to not only monitor what is going on at a remote location but also do something about it. The supervisory control part of SCADA takes care of that. **IT**

Stuart Boyer is a senior member of ISA and author of ISA's Independent Learning Module, titled SCADA.